

IN THE SPECIFICATION:

At page 1, please amend the paragraph beginning on line 11 as follows:

--The water fraction meters used in the oil process industry ~~to-day~~today will all be influenced by the gas content in the oil/water/gas-mixture and different kinds of iterative algorithms are used to compensate for this error. ~~Micro-wave~~Microwave meters are dependent on the salinity of the water component in both oil and water continuous phases and capacitance meters must be equipped with a conductivity meter to cover the whole range of water fraction from 0 to 100%.--

At page 1, please amend the paragraph beginning on line 20 and ending on page 2, line 4 as follows:

--The object of the present invention is to provide for a method and arrangement to be able to effect determining the content of a conductive fraction in a multiphase flow wherein the conductive phase exist in a range of being continuous or being included in the multiphase flow as droplets.--

At page 2, please amend the paragraph beginning on line 5 as follows:

--A multi phase flow of water/oil/gas may exhibit a water-continuous phase or an oil-continuous phase, for example.--

At page 2, please amend the paragraph beginning on line 8 as follows:

--In particular the purpose of the invention is to provide for a method and apparatus to determine the conductive water phase in said whole range of water-continuous and oil-continuous phases.--

At page 2, please amend the paragraph beginning on line 12 as follows:

--The method according to present invention is characterized by on line measuring the fraction of the conductive component in the multi phase flow by using a coil design optimiszed for non-conductive continuous mixtures, and a coil optimiszed for conductive continuous mixtures~~-mixtures~~.--

At page 2, please amend the paragraph beginning on line 18 as follows:

--The preferred embodiments appear ~~in the dependent method claims~~as described below in detail.--

At page 2, please amend the paragraphs beginning on lines 20 and 22 as follows:

--The arrangement according to present invention is for determining water content in multi phase flows in a fluid transporting body comprising a coil design optimized for non-conductive continuous mixtures, and a coil optimized for conductive continuous mixtures ~~appears in independent claim 14.~~ ~~The preferred Preferred~~ embodiments of the arrangement appear in detail below~~the dependent claims 15-20.~~ --

At page 2, please amend the paragraph beginning on line 24 as follows:

--According to the invention, the above-mentioned method and arrangement ~~according to preceding claims,~~ are suitable for determining the water content of a multi phase flow of oil, ~~hydro-carbon~~hydrocarbon gases and water, in that water is the conductive component to be determined, and the oil and gas phases being the non-conductive phase.--

At page 2, please amend the paragraph beginning on line 30 as follows:

--According to a specific embodiment, the method is used for measuring the water content in oil/gas/water multiphase mixture flows wherein the different phases in the crude are separated, i. e. not homogeneously mixed.--

At page 2, please amend the paragraph beginning on line 34 as follows:

--In the following, the invention will be disclosed in relation to a multi phase mixture of water, oil and gas, while it ~~is obvious~~should be evident that it may be applied to any multi phase mixture including one liquid conductive phase.--

At page 3, please amend the paragraph beginning on line 1 as follows:

--The water fraction meter described thus can detect the water fraction in ~~three~~three phase flows on line independent of the gas content in the mixture. ~~To day~~Today the conductivity of the water component is determined off line by laboratory tests of processed water. The described instrument can monitor the water conductivity on line.--

At page 3, please amend the paragraph beginning on line 11 as follows:

--Figure 2 shows a curve of the penetration depth as a function of the frequency of the coil, i. e. the skin depth in ~~mm~~micrometers of the Cu lead (conductor) of the coil as a function of frequency (Mhz).--

At page 3, please amend the paragraph beginning on line 15 as follows:

--Figure 3 shows the result an experiment measuring an oil/gas/water mixture phase with a particular coil design, ~~as~~with the impedance shown as a function of the water fraction in a multi phase flow to be determined. This coil design is sensitive for the water content in the mixture over the whole range, i. e. from the oil continuous phase to the water continuous phase. The steep area of the curve represents the transition area between the oil-~~continuous~~continuous (left side of curve) and water-continuous phases (right side of curve).--

At page 3, please amend the paragraph beginning on line 24 as follows:

--Figure 4 shows the results of measurements effected with a coil which has increased sensitivity for oil/gas continuous mixtures ~~phase~~-(the left side of curve).--

At page 3, please amend the paragraph beginning on line 30 as follows:

--Figure 6 shows an arrangement for utilizing this induction principle in a tomographic arrangement.--

At page 3, please amend the paragraph beginning on line 35 and ending on page 4, line 21 as follows:

--A sketch of the meter spool pipe principle is shown in the enclosed figure 1. There is shown an electrical insulated liner 10 (a coil pipe) around which excitation and detection coils 12,14 are arranged. The insulated liner may be a pipe prepared of a ceramic, plastic or a peek material and is, with all elements intsalld, arranged to be inserted in fluid flow conducting pipe. The coils 12,14 are protected by a screen (a steel material) 16 enclosing the central pipe section. The space between the screen and the pipe outer surface is filled with an inert material. The purpose of the screen to make resistance to the fluid flow pressure inside the liner 10. Each coil ~~of~~having reference numbers 12 and 14 is used as an excitation coil and a detection coils. The coils are parts of an oscillator unit supplying ~~alternat~~alternating voltage to the coils. The oscillator frequency is dependent ~~of~~on the inductance and capacitance of each coil. Each coil 12 and 14 includes a different number of coil windings. The coil wires are preferaly made of flat Cu-lices (copper), of a rectangular cross section, the thickness of which being up to 40 um in order to avoid any influence of changing resistance as the frequency is changing. This appears in figure 31. The direction of the multi phase flow through the pipe is shown by F.--

At page 4, please amend the paragraph beginning on line 22 and ending on page 5, line 4 as follows:

--Each coil (12 or 14 in figure 1) can be regarded as a parallel coupling between an inductance, a capacitance and a resistance. The capacitance consists of different spread capacitances between the coil windings and an equivalent parallel resistance made up by the resistance in the coil windings and the power loss in the volume of the mixture flowing through the coil. The first one is constant but the second one is dependent on the amount of water in the mixture. The coil is part of a feedback circuit ~~with~~which latch the excitation frequency to the coil's ~~resonance~~resonant frequency. The current in the feedback loop will then be dependent on the induced power loss in the mixture. The resonance frequency can be determined by the number of windings in the coil and the optimal frequency range will be dependent on the current penetration depth and the induced power loss in the multi phase flow mixture. The higher the frequency the higher is the loss and thus the

higher is the sensitivity of the meter, but the frequency is limited by the current penetration depth of the induced current in both the mixture and the coil windings.--

At page 5, please amend the paragraph beginning on line 5 as follows:

--In oil/gas continuous mixtures the water consists ~~as of~~ insulated droplets in the oil/gas. The induced loss in these distributed droplets is small compared to the loss in water continuous mixtures (this is the reason for making the power transformer cores of thin insulated steel plates). However, the penetration depth of the eddy currents is large so we can use a higher resonance frequency and thus increase the sensitivity.--

At page 5, please amend the paragraph beginning on line 13 as follows:

--Due to this fact two coils are used in the meter according to the invention, and they are simultaneously optimiszed for oil/gas continuous mixtures and water continuous mixtures respectively.--

At page 5, please amend the paragraph beginning on line 30 and ending at page 6, line 7 as follows:

--The eddy current loss in an infinitely large plate with thickness  $d$  (meter) and electrical conductivity  $\sigma$  (~~Siemens/meter~~ohm-meter)<sup>-1</sup>, penetrated by a magnetic field  $B$  (Tesla) parallel the plate at a frequency  $\omega$  (radians/second), is:

$$(1) \quad P_0 = \frac{\sigma \omega^2 d^2 B^2}{12}$$

where  $B$  is the rms-value of the penetrating magnetic field,  $\sigma$  the conductivity of the medium and.  $\omega$  the frequency of the magnetic field. The resonance frequency for the different coils lays in the region of 2 to 8 MHz and the electrical conductivity in processed water from the North Sea oil is 4-6 ~~S/m~~S/(ohm-meter)<sup>-1</sup>.--

At page 6, please amend the paragraph beginning on line 20 as follows:

--The skin depth in ~~Tmm~~micrometers of the Cu lead in the coil as a function of frequency (Mhz) is shown in the following Figure 2. The figure shows that the thickness of the Cu lead ~~preferable~~ preferably is up to 40 $\mu$ m.--

At page 7, please amend the paragraph beginning on line 12 as follows:

--Fig. 4. shows a coil which has an increased sensitivity for oil/gas continuous mixtures. Thus, in the oil/gas continuous range, there is marked reduction in impedance as the water fraction increases and a change of water content in the fluid mixture is possible to measure in this range. But it is almost impossible to measure a change in water fraction exceeding about 0,~~275~~0.275, as the impedance remains constant within said range.--

At page 7, please amend the paragraph beginning on line 20 as follows:

--Fig. 5. gives the result from the application of a coil configuration that has an increased sensitivity for water continuous mixtures. Thus, in the water continuous range, there is a marked reduction in impedance as the water fraction increases, and therefore a change of water content in the fluid mixture is possible to measure in this range. But it is almost impossible to measure a change in water fraction up to about 0,~~20~~0.2 as the impedance does not change much within this range.--

At page 7, please amend the paragraph beginning on line 34 and ending at page 8, line 2 as follows:

--When the different phases in the crude are separated, i. e. not homogeneously mixed, the water content can not be measured with the same accuracy as for homogeneous mixtures if the principle explained above is used.--

At page 8, please amend the paragraph beginning on line 3 as follows:

--The arrangement for utilizing this induction principle in a tomographic arrangement is shown in Fig. 6.--

At page 8, please amend the paragraph beginning on line 5 as follows:

--Fig. 6. is a proposed coil arrangement which coils together form a meter for tomographic detection of multiphase flow. The figure shows a pipe section 20 of the same material as illustrated in figure 1. To the outside surface of the pipe 20, a number of 8 coil units 22 are mounted in close ~~contacting~~contact with the pipe surface 24. The three phases of gas 26, oil 28 and water 30 are shown inside the pipe section. The water amount may now be measured by means of the arrangement according to figure 6.--

At page 8, please amend the paragraph beginning on line 15 as follows:

--Here we can determine the power loss generated in the alternating magnetic field from one coil at ~~thea~~ time. Based on mathematical models of the magnetic field from the coils it is possible to work out a reconstruction algorithm for imaging the water distribution in the meter cross section. It may also be possible to excite one of the coils at a time and use all the other coils as pick up coils and detect the attenuation of the magnetic field from the transmitter to the receiver coils and thus reconstruct a picture of the area of low field penetration which must be areas of water.--

At page 8, please amend the paragraph beginning on line 26 as follows:

--In the new solution, a different electronics is used. Here a resonance circuit is used wherein the resonance frequency ~~is changing~~changes as a function of changes in water content and salinity. Also the impedance at resonance changes due to these ~~amendments~~changes. By using a resonance circuit the frequency is always locked at the resonance frequency, wherein the sensitivity for changes is greatest. Thus one saves one coil so that the new solution is cheaper and simpler.--

At page 8, please amend the paragraph beginning on line 35 and ending at page 9, line 3 as follows:

--In an oil-water mixture the flow may be divided in oil-continous flows at low water fractions and water- continous flows at low oil fractions. As can be seen

from the plot, where the impedance is plotted as a function of the water fraction, the curve exhibits a discontinuity. At this point, the flow ~~shanges~~changes from oil-continuous to water-continuous or vice versa. See figures 3,4 and 5.--

At page 9, please amend the paragraph beginning on line 7 as follows:

--This provides for excellent flexibility where the sensitivity may be optimized for a given application.~~For,~~ for example if one wishes to obtain a maximum sensitivity for low water fractions in oil. In another application one may wish a maximum sensitivity for low oil fractions in water. This requires two different coils according to the invention, and if two coils according to figure 1 are combined, a maximum sensitivity over the whole of the measuring area (see figures 4 and 5) is obtained. A possibility to compensate for changes in salinity is another advantage which may be obtained.--

At page 9, please amend the "REFERENCES" section as follows:

--REFERENCES.

[1] Maxwell, J. C.: «"A Treatise on Electricity & Magnetism»"

The Clarendon Press, Oxford, Vol. 1, 1st edition 1873.

[2] Bruggeman, D. A. G.: «"Berechnung verschiedener physikalischer Konstanten von heterogenen Substanzen»". Annalen der Physik, 5. Folge, Band 24,1935

[3] Ragnvald Soldal, Detection of Water Cut and Levels in Separator Using High Frequency Magnetic Field (In Norwegian), Cand. Scient Thesis, University of Bergen, 1999.

[5] A J Peyton, M S Beck, A R Borges, J E de Oliveira, G M Lyon, Z Z Yu, M W Brown, J Ferrerra, Development of Electromagnetic Tomography (EMT) for Industrial Applications. Part 1 : Sensor Design and Instrumentation.

Proceedings of 1st World Congress on Industrial Process Tomography, Buxton, Greater Manchester, April 14-17,1999, 306.--